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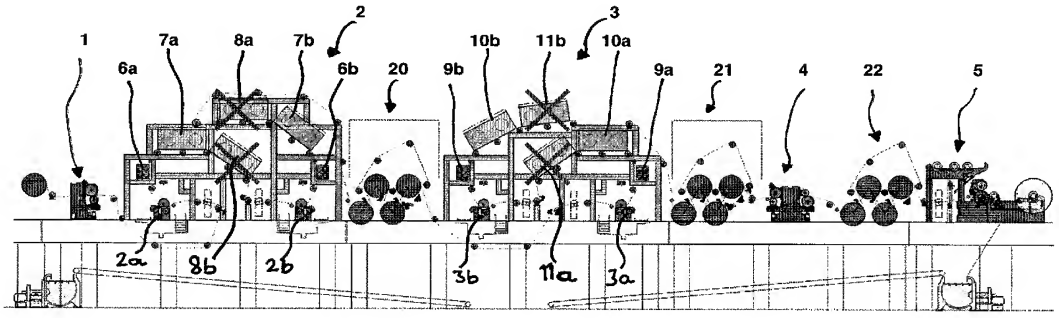
(54) **Title:** METHOD AND APPARATUS FOR PRODUCING COATED PAPER OR BOARD



(57) **Abstract:** The invention relates to a method for producing coated paper or board. In the method, the fibrous web being coated is conveyed to a precalendering device before coating and the paper or board is dried in one or more stages and dried after at least one coating stage. In the method is used a precalender and/or an intermediate calender which is selected from a group comprising a metal belt calender and a long-nip calender. In the method is performed efficient drying with a vaporization efficiency exceeding 40 kg/m2/h after the said at least one coating stage.

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Method and apparatus for producing coated paper or board

The present invention relates to a method and apparatus for producing coated paper or board, the said paper or board being precalendered before coating and dried after coating.

There are numerous different paper and board grades and they can be divided into two categories by basis weight: papers, which have one layer and a basis weight of 25-300 g/m^2 and boards made by multi-layer technique and having a basis weight of 150-600 g/m^2. As can be seen from this, the borderline between paper and board is a sliding one since boards having the lightest basis weight are lighter than the heaviest of papers. Paper is generally used for printing and board for packaging. Paper and board may be coated or uncoated.

The following descriptions are examples of values currently used for fibrous webs to be coated and they may contain considerable variation from the disclosed values. The descriptions are based mainly on the source publication Papermaking Science and Technology, section Papermaking Part 3, Finishing, edited by Jokio, M., published by Fapet Oy, Jyväskylä 1999, 361 pages.

Coated magazine paper (LWC = light weight coated) contains 40-60% mechanical pulp, 25-40% bleached softwood pulp, and 20-35% fillers and coaters. As general values for LWC paper may be regarded the following: basis weight 40-70 g/m^2, Hunter gloss 50-65%, PPS S10 roughness 0.8-1.5 µm (offset) and 0.6-1.0 µm (roto), density 1100-1250 kg/m^3, brightness 70-75%, and opacity 89-94%.

As general values for MFC paper (machine finished coated) may be regarded the following: basis weight 50-70 g/m^2, Hunter gloss 25-70%, PPS S10 roughness 2.2-2.8 µm, density 900-950 kg/m^3, brightness 70-75%, and opacity 91-95%.

As general values for FCO paper (film coated offset) may be regarded the following: basis weight 40-70 g/m^2, Hunter gloss 45-55%, PPS S10 roughness 1.5-2.0 µm, density 1000-1050 kg/m^3, brightness 70-75%, and opacity 91-95%.

As general values for MWC paper (medium weight coated) may be regarded the following: basis weight 70-90 g/m^2, Hunter gloss 65-75%, PPS S10 roughness 0.6-1.0 µm, density 1150-1250 kg/m^3, brightness 70-75%, and opacity 89-94%.

HWC (heavy weight coated) has a basis weight of 100-135 g/m^2 and it can be coated even more than twice.

In coated wood-free chemical-pulp based printing papers (WFC), or fine papers, the amounts of coating vary greatly in accordance with the requirements and intended use. The following are typical values for once and twice coated chemical-pulp based printing paper: basis weight of once coated 90 g/m^2, Hunter gloss 65-80%, PPS S10 roughness 0.75-2.2 µm, brightness 80-88%, and opacity 91-94%, and basis weight of twice coated 130 g/m^2, Hunter gloss 70-80%, PPS S10 roughness 0.65-0.95 µm, brightness 83-90%, and opacity 95-97%.

Boards constitute a fairly heterogeneous group which includes grades having a high basis weight of up to 500 g/m^2 and grades having a low basis weight of about 120 g/m^2, the grades ranging from ones based on virgin fibre to 100% recycled fibre based grades, and from uncoated to multiply coated. Coated board grades include the following:

- virgin fibre based folding boxboard (FBB), bleached pulp board (SBS = solid bleached board), liquid packaging board (LPB), coated white top liner, carrier board
- recycled fibre based white-lined chipboard (WLC), coated recycled board.

The texture of the coating and the printing properties of a coated fibrous web can be influenced by the drying conditions. Variation in the amount of coating due to the unevenness of the base of the coated fibrous web causes problems in the drying of the coating. Excessive drying power in the paste solidification area causes, for example, mottling in the print quality. This situation is emphasised especially with board, where coating is typically performed with blade coaters. When the excess coating is doctored with a blade, variation in the amount of coating may be several grams per square metre. Precoating does not necessarily cover the base board properly, which means that there may appear absorption differences in the surface coating. Attempts are made to control the drying of the coating by means of a so-

called "high-quality air dryer", that is, an air dryer having a limited vaporization efficiency (kg/m^2/h) for obtaining a controlled coating texture. The vaporization efficiency is limited by limiting the blasting speed and/or the temperature. Excessive vaporization efficiency results in an uneven absorption, and thus also distribution, of water-soluble binders in the coating layer, and, therefore, in an uneven absorption of printing ink in the printed product. This appears as mottled distribution of the printing ink. The success of drying depends on how well the different amounts of coating match the "high-quality air dryer" at their point of solidification. In addition to the high-quality air dryer, two other dryers are usually required for the drying - typically one preceding the "high-quality air dryer" and one following it - in some cases as many as three other dryers are required. Several dryers lengthen the coating head and increase the price.

In drying capacity calculations of coating processes, vaporization efficiencies of over 40 kg/m^2/h are typically not exceeded in the coating paste solidification region. An attempt is made to match the solidification point with the air dryer with maximum running values of 250 °C and 40 m/s.

Figure 1 shows diagrammatically a coating machine arrangement according to the prior art. The arrangement comprises a hard-nip calender 1 acting as a precalender, followed by a precoating head 2, with a precoating head 2a of the first side, which is followed by an infrared dryer 6a, a "high-quality air dryer" 7a, that is, an air dryer with limited vaporization efficiency, and a air dryer 8a, from where the web is conveyed to the precoating head 2b of the other side, which is followed by an infrared dryer 6b, a "high-quality air dryer" 7b, that is, an air dryer with limited vaporization efficiency, and air dryer 8b. The coating heads 2a, 2b are trailing blade coaters. After the precoating head 2, the fibrous web is conveyed via the drying cylinders 20 to the coating head 3 proper, which comprises trailing blade coater heads 3a, 3b and drying devices 9a, 10a, 11a; 9b, 10b, 11b corresponding to those in the precoating stage. The fibrous web is then conveyed via a second drying cylinder group 21 to a soft calender 4 acting as an end calender, and from there via the drying cylinders 22 to the reeler 5.

The aim of the present invention is to provide a solution by means of which the space requirement of the machine used for producing coated fibrous web can be substantially reduced, thus resulting in cost savings.

To achieve this aim, the method according to the first aspect of the invention is characterised in that in the method is used a precalender and/or an intermediate calender selected from a group comprising a metal-belt calender and a long-nip calender, and that in the method is carried out efficient drying with a vaporization efficiency exceeding 40 kg/m^2/h after the at least one coating stage. According to a second aspect of the invention, the method is characterised in that in the method, a metal-belt calender is used as a precalender and that coating is carried out as blade coating, and that after at least one blade coating stage, efficient drying is carried out with a vaporization efficiency exceeding 40 kg/m^2/h.

The apparatus according to the invention is, on the other hand, characterised in that the precalender is a metal-belt calender or a long-nip calender, and that following the at least one blade coating device is an efficient drying device having a vaporization efficiency exceeding 40 kg/m^2/h.

The invention is described in greater detail in the following, with reference to the accompanying drawings, in which:

Figure 1 shows a prior art coating device arrangement as a diagrammatic view in principle,

Figure 2 shows the test results for the mottling values of printing when using the method according to the invention, compared with values obtained when using a prior art method.

To implement the method according to the invention, the following changes are made to the prior art coating device arrangement as an example: the hard-nip calender 1 is replaced with a metal-belt or long-nip precalender, the infrared dryer 6a is replace with a high-capacity air dryer, and the "high-quality air dryer" 7a is replaced by a normal air dryer and the air dryer 8a is left out. The dryers 6b and 7b following the precoating head 2b of the other side are replaced by corresponding air

dryers and dryer 8b is left out correspondingly. Corresponding changes are made to the coating head 3 proper, which means that in this example, altogether four dryers 8a, 8b, 11a and 11b can be removed, which are marked with crosses in Figure 1.

Table 1 shows an example calculation of drying when using a prior art method and when using a method according to the invention, where final moisture is in both cases essentially of the same order.

Table 1

	Current technique	Process of invention
Running speed	800 m/min	800 m/min
Weight of base	250 g/m^2	250 g/m^2
Moisture at entry at head	7%	7%
Amount of coating and dry content	12 g/m^2/63%	12 g/m^2/63%
1st dryer	Gas infrared 3 rows 100%	PDPlus 450 °C/60/ m/s
2nd dryer	Length 2.7 m 250 °C/60/ m/s	-
3rd dryer	Length 2.7 m 350 °C/55/ m/s	Length 2.7 m 350 °C/55 m/s
Cylinders	1 bar	1 bar
Final moisture	6.65%	6.75%
Evaporation per square metre at solidification point	25 kg/m^2/h	90 kg/m^2/h

The method according to the invention makes it possible to leave out one or more dryers after the blade coating head, which results in considerable cost savings. Overall savings accumulate from both leaving out dryers and shortening of the apparatus, whereupon also the requirement for hall space diminishes, thus resulting in further savings.

Figure 2 illustrates how the precalendering method and the drying conditions of the surface coating affect the mottling values of a printed surface. Figure 2 shows that

when metal-belt precalendering is used, the mottling values do not change essentially even though infrared drying is changed to efficient air drying. However, when a Yankee cylinder and a hard-nip calender are used for the pre-treatment of the base web, the mottling values clearly increase when changing over from infrared drying to efficient air drying.

In the method according to the invention, precalendering is performed on the long-nip calender or metal-belt calender in such a way that the dwell time of the fibrous web on the nip or in the calendering zone is more than 10 ms and the Bendtsen roughness of the fibrous web after precalendering is within the range from 50-1000 ml/min, preferably within the range from 100-300 ml/min. Coating is preferably performed as blade coating, for example, 1-3 coatings per side.

In prior art solutions, the efficiency of the first dryer following the coating head may not be so high that the solidification point of the coating paste will match it. Excessive vaporization efficiencies result in an uneven absorption, and thus also distribution, of water-soluble binders in the coating layer and, therefore, in an uneven absorption of printing ink in the printed product. It is for this reason that the aim in the prior art is to match the solidification point with the high-quality air dryer having maximum running values of 250 °C and 40 m/s.

In the method according to the invention, the precalendered base can be made more even by using a long-nip calender or a metal-belt precalender, which means that the coating made by blade coating has a more uniform thickness, thus allowing the use of more efficient drying, in which case the first dryer can be freely dimensioned and the high-quality air dryer may be replaced, for example, with a high-capacity air dryer. In the solution according to the invention, efficient drying is carried out using a vaporization efficiency exceeding 40 kg/m^2/h at the solidification point, preferably with a vaporization efficiency exceeding 60 kg/m^2/h and it may preferably exceed 90 kg/m^2/h. This type of efficient dryer may be located after one or more coating heads or, for example, after each coating head. In the method may additionally be used a long-nip calender or a metal-belt calender as an intermediate calender between coating heads.

Claims

1. A method for producing coated paper or board, in which method the fibrous web being coated is conveyed to a precalendering device before coating, and in which method the paper or board is dried after at least one coating stage, **characterised** in that in the method is used a precalender and/or an intermediate calender which is selected from a group comprising a metal belt calender and a long-nip calender; that in the method is performed efficient drying with a vaporization efficiency exceeding 40 kg/m^2/h after the said at least one coating stage; that precalendering is performed so that the Bendtsen roughness (SCAN-P21:67) of the surface being coated is within the range from 50-1000 ml/min, preferably within the range from 100-300 ml/min; and that the dwell time of the fibrous web on the nip or in the calendering zone is more than 10 ms.

2. A method as claimed in claim 1, **characterised** in that the vaporization efficiency of the drying stage following the said at least one coating stage exceeds 60 kg/m^2/h.

3. A method as claimed in claim 1, **characterised** in that the vaporization efficiency of the drying stage following the said at least one coating stage exceeds 90 kg/m^2/h.

4. A method as claimed in any of the claims 1 to 3, **characterised** in that the said efficient drying is performed in connection with multi-stage coating after two or more coating stages.

5. A method as claimed in any of the claims 1 to 3, **characterised** in that the said efficient drying is performed in connection with multi-stage coating after each coating stage.

6. A method as claimed in any of the above claims, **characterised** in that blade coating is used for the coating.

7. A method for producing coated paper or board, in which method the web being coated is conveyed to a precalendering device before coating, and in which method

the paper or board is coated in one or more stages, **characterised** in that in the method, a metal belt calender is used as a precalender and that coating is performed as blade coating, and that after at least one blade coating stage is performed efficient drying with a vaporization efficiency exceeding 40 kg/m^2/h.

8. An apparatus for producing coated paper or board, the apparatus comprising a precalender (1) and at least one coating device (2a, 2b; 3a, 3b), and at least one drying device (6a, 7a; 6b, 7b), **characterised** in that the precalender (1) is a metal belt calender or a long-nip calender, and that following the at least one coating device is an efficient drying device having a vaporization efficiency exceeding 40 kg/m^2/h.

9. An apparatus as claimed in claim 8, **characterised** in that the drying device is an infrared device or an air dryer.

10. An apparatus as claimed in claim 8 or 9, **characterised** in that the coating device (2a, 2b; 3a, 3b) is a blade coater.

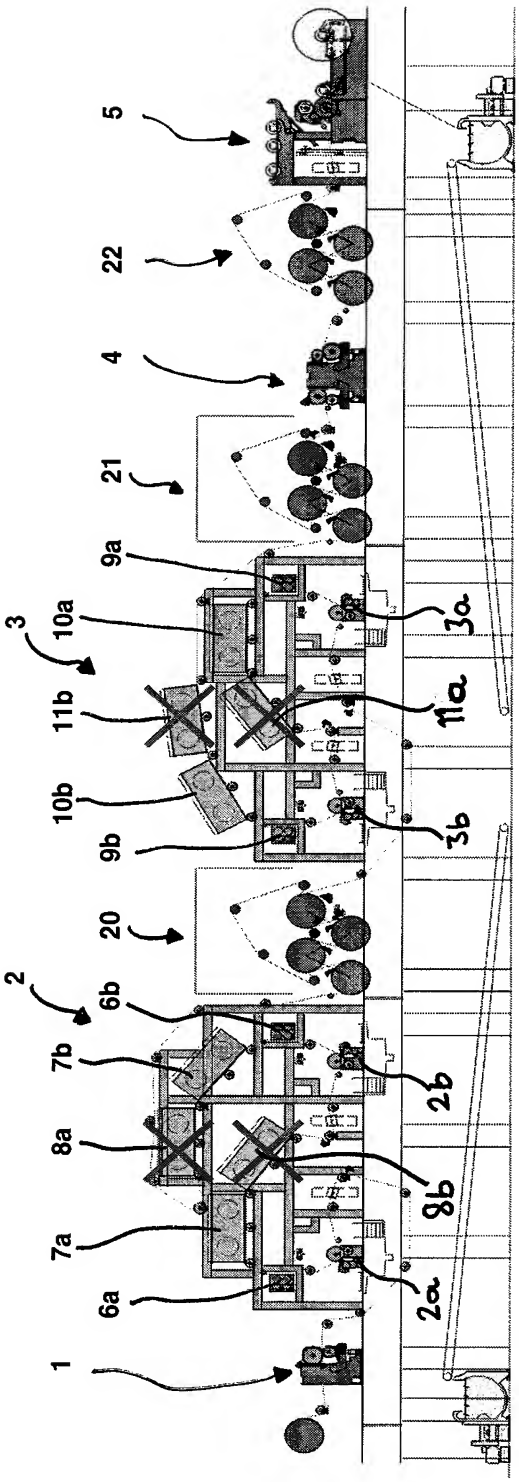

Fig. 1

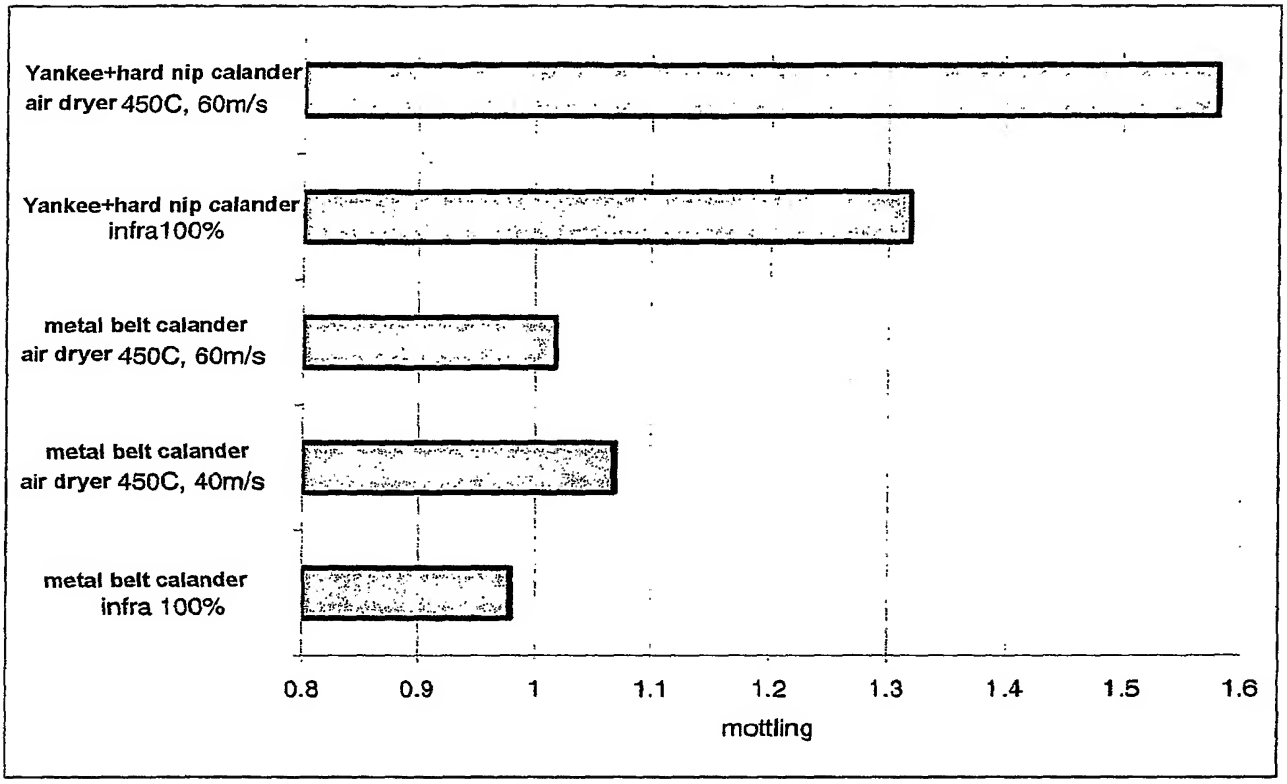
Yankee+hard nip calander air dryer 450C, 60m/s
Yankee+hard nip calander infra100%
metal belt calander air dryer 450C, 60m/s
metal belt calander air dryer 450C, 40m/s
metal belt calander infra 100%
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
mottling

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2007/050129

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21F, D21G, D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006024695 A1 (METSO PAPER, INC.), 9 March 2006 (09.03.2006), page 5, line 9 - line 15; page 2, line 14 - line 15; page 3, line 27, page 19, line 10 - line 13; page 11, line 31 - page 12, line 2	1-8,10
Y		9
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Y	WO 02103109 A1 (METSO PAPER, INC.), 27 December 2002 (27.12.2002), page 22, line 17 - line 21	9
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Y	US 6712931 B1 (GRÖN ET AL), 30 March 2004 (30.03.2004), column 3, line 14 - line 31	9
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2007	28 -06- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bertil Dahl/ELY Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2007/050129

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 20040060676 A1 (GRON ET AL), 1 April 2004 (01.04.2004), page 4, paragraph [0064]; page 5, paragraph [0073]	9
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A	WO 0052265 A1 (VALMET CORPORATION), 8 Sept 2000 (08.09.2000)	1-10
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D21H 23/34 (2006.01)

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Cited literature, if any, will be enclosed in paper form.

WO	2006024695	A1	09/03/2006	EP	1784535	A	16/05/2007
				FI	20045321	A	03/03/2006
WO	02103109	A1	27/12/2002	CA	2467100	A	27/12/2002
				CN	1703552	A	30/11/2005
				EP	1417377	A	12/05/2004
				FI	20011291	A	19/12/2002
				JP	2004530063	T	30/09/2004
				US	20050011624	A	20/01/2005
US	6712931	B1	30/03/2004	AT	279577	T	15/10/2004
				BR	0002189	A	02/01/2001
				CA	2307991	A,C	12/11/2000
				CN	1274028	A	22/11/2000
				CN	1298928	C	07/02/2007
				DE	60014759	D,T	20/10/2005
				EP	1054100	A,B	22/11/2000
				FI	105118	B	00/00/0000
				FI	991095	D	00/00/0000
				JP	2000345490	A	12/12/2000
US	20040060676	A1	01/04/2004	AU	1407602	A	21/05/2002
				DE	60125582	D	00/00/0000
				EP	1337705	A,B	27/08/2003
				AT	349566	T	15/01/2007
				WO	0238858	A	16/05/2002
WO	0052265	A1	08/09/2000	AU	2920000	A	21/09/2000
				DE	10084320	T	29/08/2002
				FI	4623	U	29/09/2000
				FI	112102	B	00/00/0000
				FI	990474	D,V	03/11/1999
				US	6863919	B	08/03/2005

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RAHKONEN SIMO	FI

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ABSTRACT:

The invention relates to a method for producing coated paper or board. In the method, the fibrous web being coated is conveyed to a precalendering device before coating and the paper or board is dried in one or more stages and dried after at least one coating stage. In the method is used a precalender and/or an intermediate calender which is selected from a group comprising a metal belt calender and a long-nip calender. In the method is performed efficient drying with a vaporization efficiency exceeding 40 kg/m2/h after the said at least one coating stage.